Citation:

Huang X, Hites RA, Foran JA, Hamilton C, Knuth BA, Schwager SJ, Carpenter DO. Consumption advisories for salmon based on risk of cancer and noncancer health effects. Environ Res. 2006 Jun;101(2):263-74.

PubMed ID: 16198332

Study Design:

Cross-sectional study

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

The purpose of this study was to apply USEPA formulations for both cancer and non-cancer health risks from fish consumption for all of the chemicals measured in a sample of salmon.

Inclusion Criteria:

N/A

Exclusion Criteria:

N/A

Description of Study Protocol:

Recruitment:

- Farmed salmon samples were purchased from 51 farms in eight farming regions in six nations (Scotland, Norway, Faroe Islands, Eastern Canada, Maine, Western Canada, Washington State, and Chile).
- Wild salmon (chum, coho, Chinook, pink, sockeye) was obtained from supplier in Alaska, British Columbia, and Oregon.
- Atlantic salmon filets were also purchased from 16 North American and European cities (Vancouver, Seattle, Low Angeles, San Francisco, Denver, Chicago, Toronto, New Orleans, Washington DC, New York, Boston, Long, Edinburgh, Paris, Frankfurt, and Oslo).
- All samples were obtained between September 2001 and December 2002.

Design

Cross-sectional analysis of a variety of salmon samples collected from around the world between Sept 2001 and December 2002.

Dietary Intake/Dietary Assessment Methodology (if applicable): N/A

Blinding used (if applicable): N/A

Intervention (if applicable): N/A

Statistical Analysis

- A two-way ANOVA was used to compare salmon from different sources and regions.
- Planned comparison contrasts were used to test the difference in contaminant concentrations based on source and region.
- Multiple pairwise comparisons were used to determine the degree to which levels of the various contaminants were correlated.

Data Collection Summary:

Timing of Measurements: All samples were obtained between September 2001 and December 2002.

Dependent Variables

- Dioxin, furan, total toxic equivalent, PCBs, organopesticide, and toxaphene concentrations for each salmon sample were measured using USEPA methods based on gas chromatographic high-resolution mass spectrometry.

Independent Variables

- Region of origin, retail market, and wild vs farmed status for each sample was determined at the time of purchase.

Description of Actual Data Sample:

Initial N:

- 459 whole farmed salmon
- 135 wild Pacific salmon
- 16 Atlantic salmon filets from retail markets

Age: N/A

Ethnicity: N/A

Other relevant demographics: N/A

Anthropometrics (e.g., were groups same or different on important measures): N/A

Location:

- Farmed salmon samples were purchased from 51 farms in eight farming regions in six nations (Scotland, Norway, Faroe Islands, Eastern Canada, Maine, Western Canada, Washington State, and Chile).
- Wild salmon (chum, coho, Chinook, pink, sockeye) was obtained from supplier in Alaska, British Columbia, and Oregon.
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Summary of Results:

PCB and Dioxin Concentration in Farmed, Wild, and Market Salmon

- PCB and dioxin levels were significantly higher in farmed and markets samples than in wild Pacific salmon
- PCB and dioxin levels in both the farmed and market samples from Northern Europe were significantly higher than those from North America, whiles levels in farmed salmon from Chile were the lowest.
- More than two-thirds of the TEQ comes from PCBs and not dioxins.

Pesticide Concentrations in Farmed, Wil, and Market Salmon

- Pesticide content is significantly higher in farmed and retail market fish compared to wild salmon; though to a lesser degree than with the PCBs.

Contaminant Concentrations in Salmon by Source and Region

- Salmon from Europe had significantly higher contaminant levels than those from North America, while salmon from South America had the least contamination.
- Farmed salmon had significantly higher contaminant levels than while salmon.
- Overall, farmed salmon are the most contaminated, salmon purchased from retail markets are less contaminated, and wild salmon is the least contaminated.

Correlations among Contaminants

- A scatter plot was produced for each pair of contaminants, and clear patterns of positive correlation were observed for all pairs of contaminants.

Author Conclusion:

- Significant contaminant levels were found in both wild and farmed fish, although levels were higher in farmed fish.
- If a fish is high in one contaminant, it is likely to be similarly high in all of the others.
- Most of the contaminants found in farmed salmon are rates as "probable" (by USEPA) or "possible" (by IARC) human carcinogens.
- A likely explanation for the high contamination of salmon may be the use of fish meal/fish oil and waste animal fats that are as food supplements. One solution may be to stop the recycling of fish and animal fats into the feed of fish and animals that are used for human consumption. Replacing fish meal/fish oils with vegetable-based food that contains lower contaminant levels may assist in reducing contamination levels.

Reviewer Comments:

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	N/A
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	N/A
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	No
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	No
2.2.	Were criteria applied equally to all study groups?	No
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
3.	**Were study groups comparable?**	No
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	No

3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	No
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	No
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A

6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	N/A
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	???
7.6.	Were other factors accounted for (measured) that could affect outcomes?	No
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes

8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	No
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes